Alternatives Analysis Workshop

Preliminary Results

Feasibility Study Update

and Workshop Introduction

April 24, 2009

High Speed Rail Feasibility Study

TEMS, Inc. / Quandel Consultants, LLC

Agenda

1. MORNING

1. Opening Comments and Today's Ground Rules
2. Public Involvement Update
3. Alternatives Evaluation Framework
4. Capital Cost Considerations

Public Involvement Update

Corridor Input Team Meeting Goals

- **Present a high-level summary of initial findings**
- **Summarize input from today's workshop**
- **Gather input to help inform RMRA decision-making process**
  - Local priorities, preferences and concerns
  - Political and other issues that should be considered

Corridor Input Team Scoping Meetings

- **Denver Metro Input Team**
  Wednesday, April 29
  9 -11 a.m.
  DRCOG, 1st Floor Board Rm.
  1290 Broadway, Denver

- **I-70 Corridor Input Team**
  Wednesday, April 29
  2 - 4:30 p.m.
  Silverthorne Library Meeting Room
  651 Center Circle, Silverthorne

- **I-25 Corridor Input Team**
  Thursday, April 30
  2 - 4 p.m.

  Two Locations:
  - North Front Range MPO (419 Canyon), #300, Ft. Collins
  - Pikes Peak Area Council of Governments (15 S. 7th), Colorado Springs

Alternatives Analysis Evaluation Framework

Alternatives Evaluation Framework

- Study & Workshop Objectives
- Proposed Preliminary Scenarios
- Why FRA Economic Criteria, and why we care?
- Alternatives Evaluation Criteria
- Technology Considerations: Novel technology, implications of FRA compliance, transportability of technology
- Capital Costing Considerations
- Route Considerations: Freight Rail Co-location and Right-of-Way Considerations

Alternatives Evaluation Framework

- **Sensitivity to Environmental Risks:**
  - Today and Corridor Input Teams will identify environmental, political and community concerns
  - Recommend it is premature to screen alternatives before documenting benefits/risks
  - Risks are analyzed and documented in the NEPA process
  - Feasibility study does not eliminate any alternatives
  - NEPA process would re-evaluate all identified alternatives and more
  - Understanding costs/benefits provides needed perspective in allocating capital to mitigate possible environmental risks
  - Respect for community values and environmental risks will be key attributes of any selected alternative
- **Preliminary Consideration of Environmental, Political, Community and Social Values**
  - Selecting reasonable routes
  - Community Input

Study & Workshop Objectives

- **What this study IS doing:**
  - Study: to assess the financial and economic feasibility of implementing a high speed inter-city ground transportation system in Colorado
  - Workshop: Stakeholder participation to inform and receive input on selection of a short list of HSR alternatives for both corridors that *meet FRA Economic criteria* and *will be further refined* in subsequent Business Plan development
- **What this study is NOT doing:**
  - Not establishing a preferred alignment
  - Not establishing a preferred technology
  - Not establishing station locations
  - Not evaluating environmental impacts/mitigation

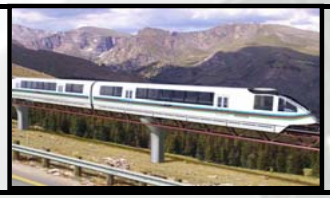
Feasible alternatives that have been identified will be further refined in the Business Plan development of this study and NEPA processes and subsequent studies.

Proposed Preliminary Scenarios

Corridor	I-25 North Wyoming Border to North Suburban Station	I-25 South New Mexico Border to South Suburban Station		I-70 East Golden to Avon	I-70 West Avon to Grand Junction
Alternative					
1					
1 (a)	Diesel, 79 mph Track Speed Existing Rail with R2C2*	Diesel, 79 mph Track Speed Existing Rail with R2C2		Not Applicable due to lack of power for gradients	Not Applicable due to lack of power for gradients
1 (b)	Diesel, 79 mph Track Speed Existing Rail, without R2C2	Diesel, 79 mph Track Speed Existing Rail, without R2C2		Not Applicable due to lack of power for gradients	Not Applicable due to lack of power for gradients
2					
2 (a)	Diesel, 110 mph Track Speed Existing Rail with R2C2	Diesel, 110 mph Track Speed Existing Rail with R2C2		Not Applicable due to lack of power for gradients	Not Applicable due to lack of power for gradients
2 (b)	Diesel, 110 mph Track Speed Existing Rail, without R2C2	Diesel, 110 mph Track Speed Existing Rail, without R2C2		Not Applicable due to lack of power for gradients	Not Applicable due to lack of power for gradients

***R2C2 refers to CDOT's freight rail relocation study**

Proposed Preliminary Scenarios

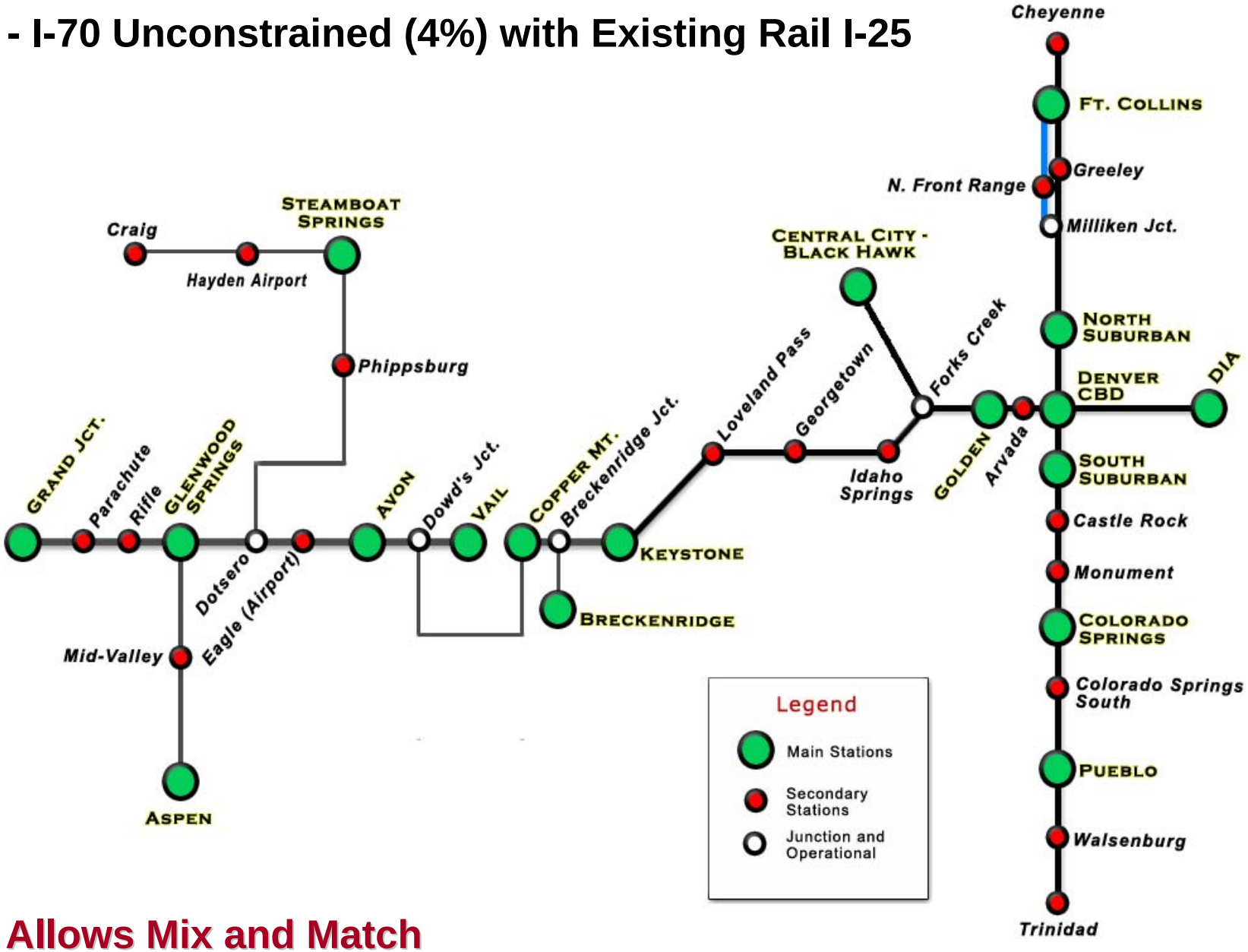
Corridor	I-25 North Wyoming Border to North Suburban Station	I-25 South New Mexico Border to South Suburban Station		I-70 East Golden to Avon	I-70 West Avon to Grand Junction
Alternative					
3					
3(a)	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-25 Highway Corridor Alignment	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-25 Unconstrained Alignment		I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-70 R.O.W. Alignment	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-70 R.O.W. Alignment
3(b)	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-25 Highway Corridor Alignment	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-25 Unconstrained Alignment		I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-70 Highway Corridor Alignment	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-70 Highway Corridor Alignment
3 (c)	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-25 Highway Corridor Alignment	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-25 Unconstrained Alignment		I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-70 Unconstrained Alignment	I-70 PEIS Advanced Guideway System Maglev, 125 mph Track Speed I-70 Unconstrained Alignment
4					
4	Electric, Locomotive Pulled 150 mph Track Speed Existing Rail, with R2C2	Electric, Locomotive Pulled 150 mph Track Speed Existing Rail, with R2C2		Electric, Locomotive Pulled 150 mph Track Speed I-70 Unconstrained Alignment	Electric, Locomotive Pulled 150 mph Track Speed I-70 Unconstrained Alignment

Proposed Preliminary Scenarios

Corridor	I-25 North Wyoming Border to North Suburban Station	I-25 South New Mexico Border to South Suburban Station		I-70 East Golden to Avon	I-70 West Avon to Grand Junction
Alternative					
5					
5(a)	I-70 PEIS Rail Alternative Electric, EMU Non Tilting 150 mph Track Speed I-25 Highway Corridor Alignment	I-70 PEIS Rail Alternative Electric, EMU Non Tilting Electric, 150 mph Track Speed I-25 Unconstrained Alignment		I-70 PEIS Rail Alternative Electric, EMU Non Tilting 150 mph Track Speed I-70 R.O.W. Alignment	I-70 PEIS Rail Alternative Electric, EMU Non Tilting 150 mph Track Speed I-70 R.O.W. Alignment
5 (b)	Electric, EMU Tilting 220 mph Track Speed I-25 Highway Corridor Alignment	Electric, EMU Tilting 220 mph Track Speed I-25 Unconstrained Alignment		Electric, EMU Tilting 220 mph Track Speed I-70 R.O.W. Alignment	Electric, EMU Tilting 220 mph Track Speed I-70 R.O.W. Alignment
5 (c)	Electric, EMU Tilting 220 mph Track Speed I-25 Highway Corridor Alignment	Electric, EMU Tilting 220 mph Track Speed I-25 Unconstrained Alignment		Electric, EMU Tilting 220 mph Track Speed I-70 Unconstrained Alignment	Electric, EMU Tilting 220 mph Track Speed I-70 Unconstrained Alignment
6					
6 (a)	Maglev, 300 mph Track Speed I-25 Highway Corridor Alignment	Maglev, 300 mph Track Speed I-25 Unconstrained Alignment		Maglev, 300 mph Track Speed I-70 Highway Corridor Alignment	Maglev, 300 mph Track Speed I-70 Highway Corridor Alignment
6 (b)	Maglev, 300 mph Track Speed I-25 Highway Corridor Alignment	Maglev, 300 mph Track Speed I-25 Unconstrained Alignment		Maglev, 300 mph Track Speed I-70 Unconstrained Alignment	Maglev, 300 mph Track Speed I-70 Unconstrained Alignment

Two Network Options to be Evaluated

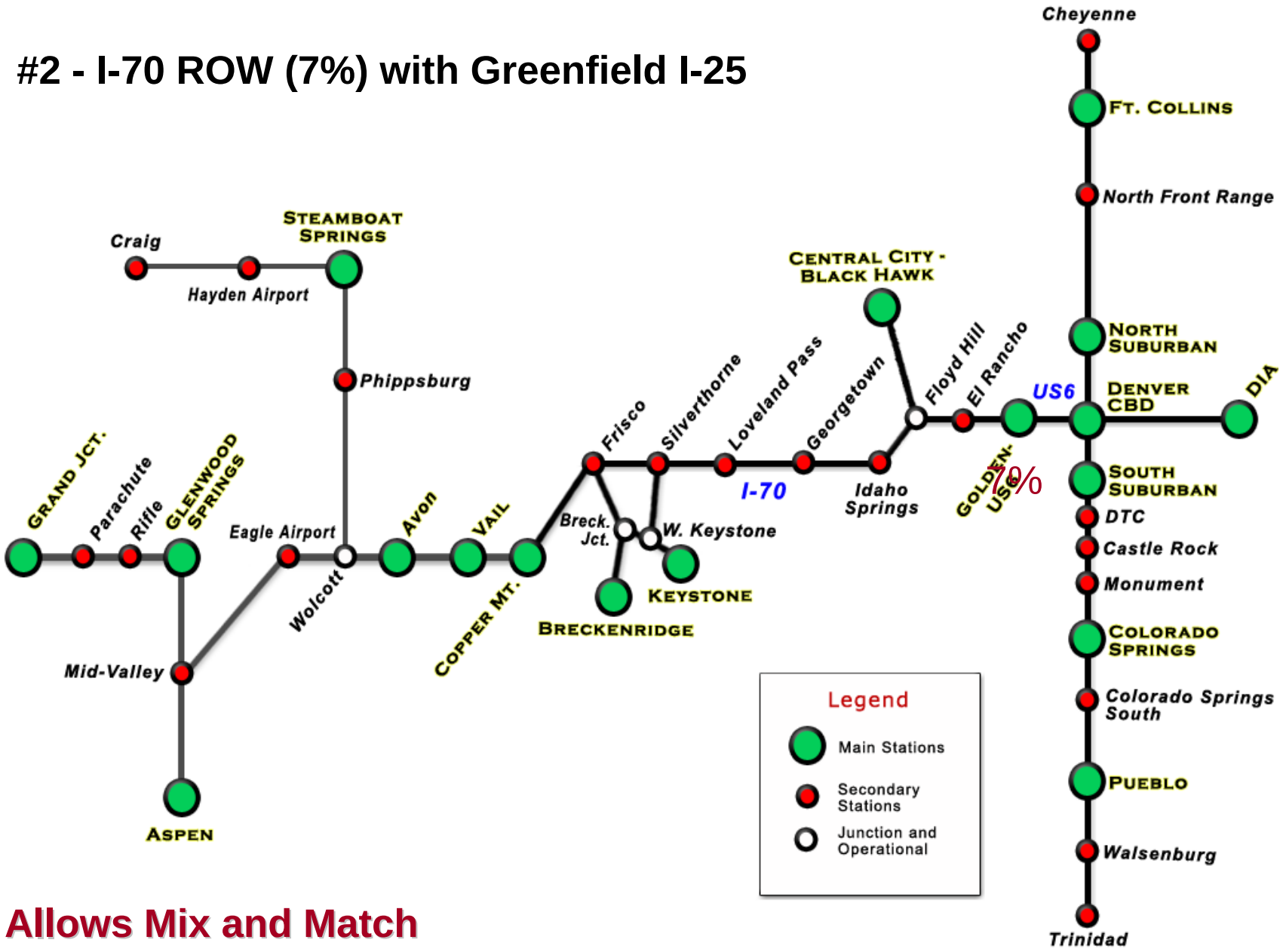
#1 - I-70 Unconstrained (4%) with Existing Rail I-25



Allows Mix and Match

Two Network Options to be Evaluated

#2 - I-70 ROW (7%) with Greenfield I-25



Allows Mix and Match

Alternatives Evaluation Criteria

- **At this point in the study, detailed analysis addresses *only* the FRA Economic Criteria:**
  - Positive Operating Ratio (Financial Analysis)
  - Positive Cost Benefit Ratio (Economic Analysis)

Source:

High Speed Ground Transportation for America, US FRA, September 1997

- **Other evaluation measures (e.g., interoperability, R2C2 risk, freight rail constraints) will be considered going forward.**

Financial Analysis (for Federal Funding Participation)

FRA requires a Positive Operating Ratio > 1.00

$$\text{Operating Ratio} = \frac{\text{Operating Revenue}}{\text{Operating Cost}}$$

Means the system can run without an operating subsidy.

Financial Analysis (for Federal Funding Participation)

- **Operating Revenue**
  - Fare Box
  - On Board Sales
  - Express Freight
- **Operating Costs**
  - Equipment Maintenance
  - Track Maintenance
  - Crew Wages + Benefits
  - Sales and Marketing
  - Station Costs
  - Administration
  - Insurance
  - Energy

Economic Analysis

FRA Requires a Positive Cost Benefit Ratio > 1.00

$$\text{Cost Benefit Analysis} = \frac{\text{Economic Benefit}}{\text{Economic Cost}}$$

Means the system produces a positive net contribution to the economic well-being of the Country.

Economic Analysis

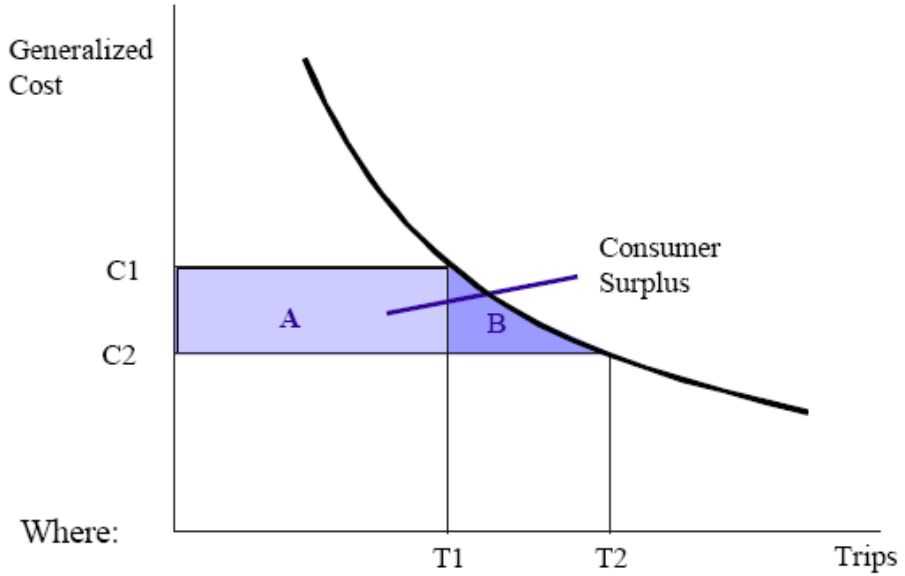
- **Economic Benefit**
  - System Revenues
  - Consumer Surplus
  - Environmental (Emissions)
  - Net Resource Savings (Energy)
- **Economic Cost**
  - Capital Cost
  - Ongoing Operating and Maintenance Costs

Economic Benefits Explained

- **Revenue is the Fare times the Ridership of the system.**
- **Consumer Surplus is economic benefit that a customer would be willing to pay for, but doesn't have to. For example:**
  - You're willing to pay $5 for a Big Mac.
  - The Price of a Big Mac is only $3.
  - Your Consumer Surplus is $2.
- **Environmental Savings are based on tonnage of emissions reduction times applicable rate (depending on whether the reduction occurs in an EPA non-attainment area.)**
- **Resource Savings reflect the operating cost savings of other modes, including fuel, traffic congestion savings, for trips that have been diverted to rail.**

Calculation of Consumer Surplus From the Demand Curve

- Consumer surplus = C1 – C2)*T1 + ((C1 – C2)*(T2 – T1))/2.
- Area A represents the improvement in consumer surplus resulting from generalized cost savings for any existing rail users, while.
- Area B represents the consumer surplus resulting from induced traffic and trips diverted to rail.



Where:

C_1 = Generalized Cost users incur before the implementation of the system

C_2 = Generalized Cost users incur after the implementation of the system

T_1 = Number of trips before operation of the system

T_2 = Number of trips during operation of the system

Example Cost Benefit Analysis (MWRRS)

- **Positive Operating Ratio**

  Present Value Revenue /
  Present Value Operating Costs
  6.8 / 5.0 = 1.36

- **Positive Cost Benefit Ratio**

  Present Value Benefits /
  Present Value Total Costs
  15.9 / 9.3 = 1.71

***Present Value = Conversion of future dollars to current dollars**

Benefits	Billions in 1998 dollars
MWRRS User Benefits	
Consumer Surplus	$6.4
(e.g., time savings expressed as dollars)	
System Revenues	$6.8
Other Mode User Benefits	
Airport Congestion Relief	0.7
Highway Congestion Relief	1.3
Resource Benefits	
Air Carrier Operating Cost Reductions	0.4
Emission Reductions	0.3
Total Benefits	$15.9
Costs	
Capital	$4.1
Financing	0.2
Operating and Maintenance	5.0
Total Costs	$9.3
Ratio of Benefits to Costs	1.7

Calculation Process

- **For the Business Plan:**
  - Cash Flow over 25 years
  - Present Value calculated by discounting
  - FRA discount rate – 3.9%
- **For Prescreening of Alternatives:**
  - An approximate projected Operating Ratio and Cost Benefit Ratio for each alternative, based on a detailed 2035 Central Growth (Population, Income & Employment)/ Central Gas Price forecast, and a benchmarking comparison with previous similar studies.

FRA Economic Criteria, and why we care?

- **FRA Economic Criteria are used to ensure:**
  - That implementation of the system produces net positive economic benefits to the economy of Colorado and the USA
  - That the ongoing subsidy requirement of the system will not become a financial burden
  - That operations of the system can be franchised to a private operator
  - It puts passenger rail on a level playing field with the operations of other intercity public transportation modes that are operated by private carriers, e.g. air and bus
  - They are a minimum requirement for eligibility for a Federal matching share through the FRA process

FRA Economic Criteria

- FRA criteria do not solely drive selection of alignment and technology
- FRA criteria are not the same as FRA equipment compliance requirements

Technology Considerations

- **"Novel" technologies can not be evaluated at the same level as "Proven" technologies because of:**
  - CDOT Transportation Commission Resolution Restricting Front Range Commuter Rail Study passed 6 to 1 in November 2006
  - DMU, EMU, Diesel Locomotive Hauled or Magnetic Levitation are the only technologies allowed by the Transportation Commission because of work done previously in I-70 Draft PEIS

Technology Considerations

“NOW THEREFORE BE IT RESOLVED, the Transportation Commission hereby directs staff to work with the Front Range Commuter Rail to collaboratively develop a scope of work for the High Speed Rail Corridor Feasibility Study project that explicitly does not duplicate the efforts of previous or current CDOT studies and published technical reports and makes the best use of the information contained in these studies to further evaluate the feasibility of rail transit in the major east-west and north-south corridors of the State of Colorado. The areas of study and technical analyses that may have already been conducted and approved include travel demand and ridership studies, alternate route studies, alternatives analysis and associated environmental analyses, various technology studies and funding information.”

Technology Considerations

- **On a technical basis, “Novel” technologies can not be evaluated at the same level as “Proven” technologies because of:**
  - Lack of reliable capital and operating cost data
  - Lack of data on market (ridership) response to new or unproven system concepts, especially in an Intercity service context
  - Base technology for Maglev-125 is in 60-mph commercial service in Nagoya, Japan as HSST. Proposed 125-mph version retained for compatibility with the I-70 PEIS.
  - Not available for near-term (10 years) application

Technology Considerations

- **FRA compliance**
  - Non-compliant technologies are included in the current study.
  - Compliance is not just a “Buff Strength” issue but affects many aspects of the equipment design.
- **Transportability of technology**
  - It has been assumed that European and Asian equipment could be modified at reasonable cost to meet US and Colorado requirements, *given an equipment order of sufficient size.* Capital costs are based on previous manufacturers’ quotes for FRA-compliant trainsets.
  - Notwithstanding the Acela precedent, a benchmarking analysis has suggested a weight penalty in the order of 10% for full FRA compliance. This weight can likely be compensated by additional power, resulting in little, if any, net degradation to performance of the train.

Ruling of Particular Applicability

- **For technologies to be used in the USA, they must receive a "Ruling of Particular Applicability" from the FRA. There is a defined process within FRA for granting this approval.**
  - ❖Rule of Particular Applicability (RPA) or Waiver
    - FRA is responsible for safety regulation of intercity rail (including maglev)
    - Extensive rail safety rules are published in 49 CFR 201-213
    - Track safety standards have been developed for speeds up to 200 mph
    - Passenger equipment safety standards have been developed for speeds up to 150 mph
    - Specific maglev technology regulations do not exist
    - For high speed applications, the FRA may resort to issuing special rules or a waiver
    - FRA sought to issue an RPA for the Florida Overland Express and published NPRM 62 FR 65478

Sensitivity to Environmental Risk

EVERY alternative has possible environmental, technical, community and other risks associated with it.

- This is why it is dangerous to prematurely screen any alternatives before both the benefits and risks have been formally documented.
- These risks will eventually be documented as part of the NEPA process.
- The feasibility study may make recommendations or suggestions, but we are not “screening” any alternatives at this phase. All the identified alternatives, and then some, would be formally re-evaluated as part of a NEPA process.
- The study’s current focus has been to establish economic tradeoffs associated with the selection of possible alternatives.
- Many options may be found economically infeasible, even before needing to spend funds for a detailed environmental evaluation of them.
- Understanding the costs and benefits associated with all options allows the most rational allocation of capital, with respect to mitigation of possible environmental risks.
- Respect for community values and environmental sensitivity will be essential attributes of any final selected alternative.

Freight Rail Right of Way

- **To share freight railroad property, FRA compliant equipment is needed.**
  - Only applies on existing rail routes on I-25 corridor, and beyond Minturn.
  - Otherwise elevated structure, very wide track spacing (which may not always be available) or completely separate rights of way (e.g. Greenfields) are needed to implement passenger rail.
- **Existing freight lines are at capacity, so we have to build all the new capacity that would be needed to provide passenger service.**
  - It has been assumed that existing capacity on some short sections, e.g. through the Littleton trench, might be made available if the R2C2 project were implemented.
  - In these areas, the freight RRs would have to acknowledge that they would not need the capacity that is freed up by R2C2 in the future.

Freight Rail Right of Way

- **R2C2 has projected significant environmental benefit, such as fuel savings, and reduced emissions and exposure to highway grade crossing accidents.**
  - R2C2 would provide significant rail cost-savings opportunity not only for passenger service south to Pueblo, but also to DIA and the northern front range cities.
  - Nonetheless, there is a risk associated with assuming relocation; legislation has been proposed to block it.

Questions

Capital Costing Considerations

Library of HSR Unit Costs

- **Extensive development for MWRRS (Midwest)**
  - Florida, Ohio, Minnesota, & California projects
- **Peer Reviewed**
  - Peer Panels
  - Freight Railroads
  - Contractors
- **DBOM proposals in Florida within 0% to 10%**
- **Consistent with Colorado Unit Costs**

Library of VHS Maglev Costs

- Report to Congress, Costs & Benefits of Magnetic Levitation, FRA, September, 2005
- Studies in San Diego, Florida, Minnesota
- Industry Peer Review of Guideway and Propulsion Costs on San Diego study
- Mature Studies in Baltimore, Pittsburgh, & Las Vegas

Adjust Unit Prices to Regional Conditions and Escalate from 2002 to 2008

- From ENR CCI Analysis, Denver to Midwest Ratio is 70% for year 2002
- Unit Prices developed in 2002 Costs
- Colorado Cost Indices 2002/08 = 2.21
- Adjust Midwest to Denver and escalate to 2008

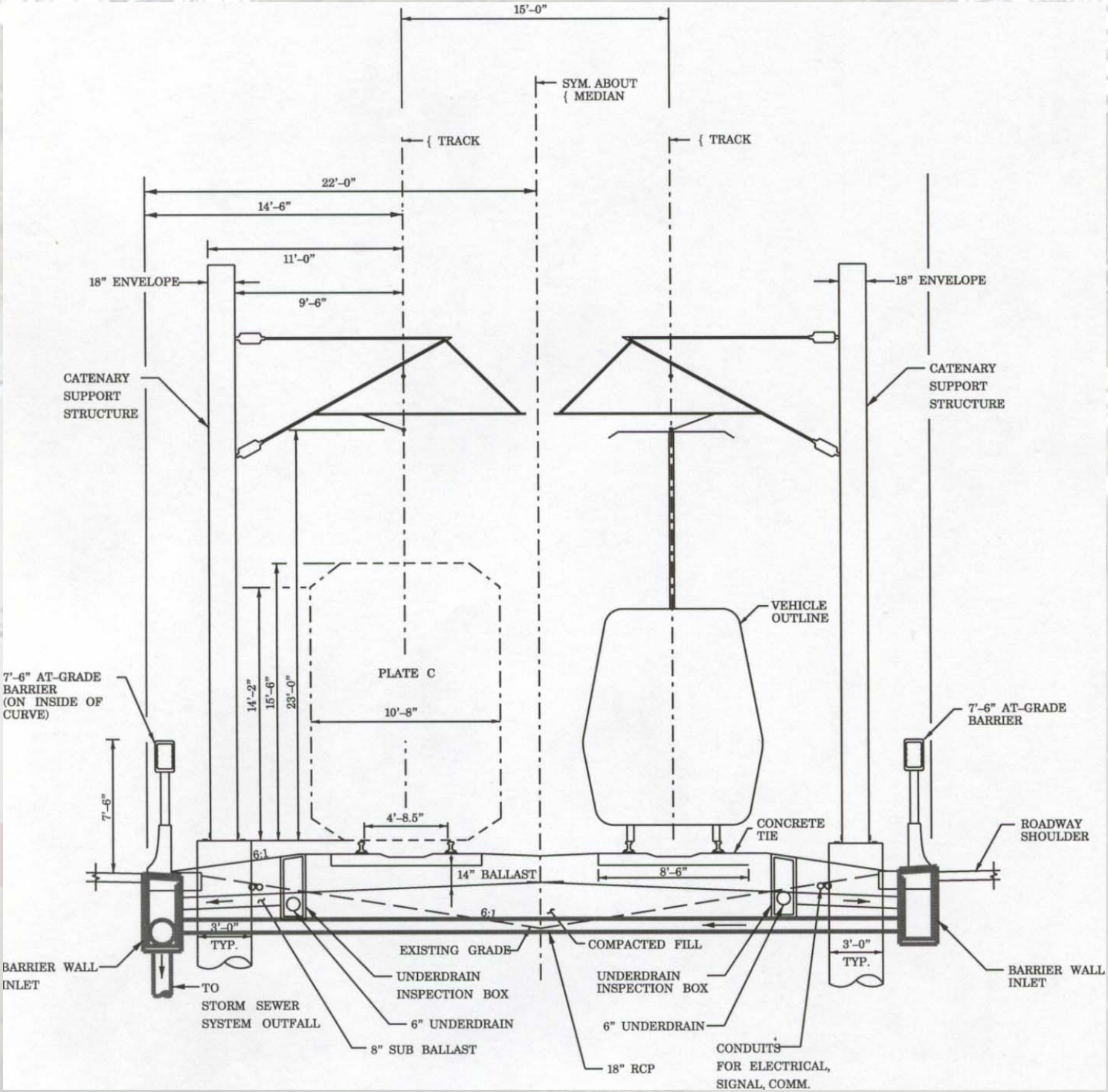
Regional Adjustment Factor = 0.7

Escalation Factor = 0.7 * 2.21 = 1.55

Rail Section

Double Track Electrified Rail Section
$3.1 M/mi

Signals, Communication & Dispatch
$1.5 M/mi



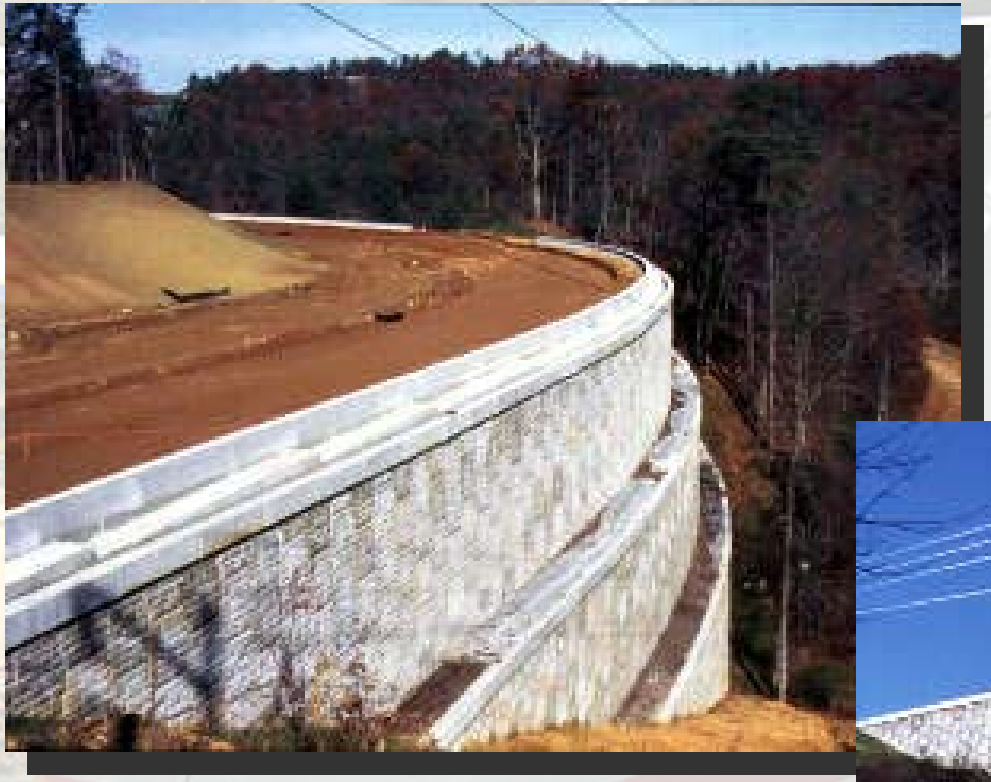
Source: ***Tampa to Miami Feasibility Study***, **Florida High Speed Rail Authority, March, 2003**

Double Track Retained Earth Fill

$16.7 M/mi

Source: Reinforced Earth Company

Approach Embankment for Double Track



$34.3 M/mi

Source: Reinforced Earth Company

Rail Elevated Structure for Double Track

$42.2 M/mi

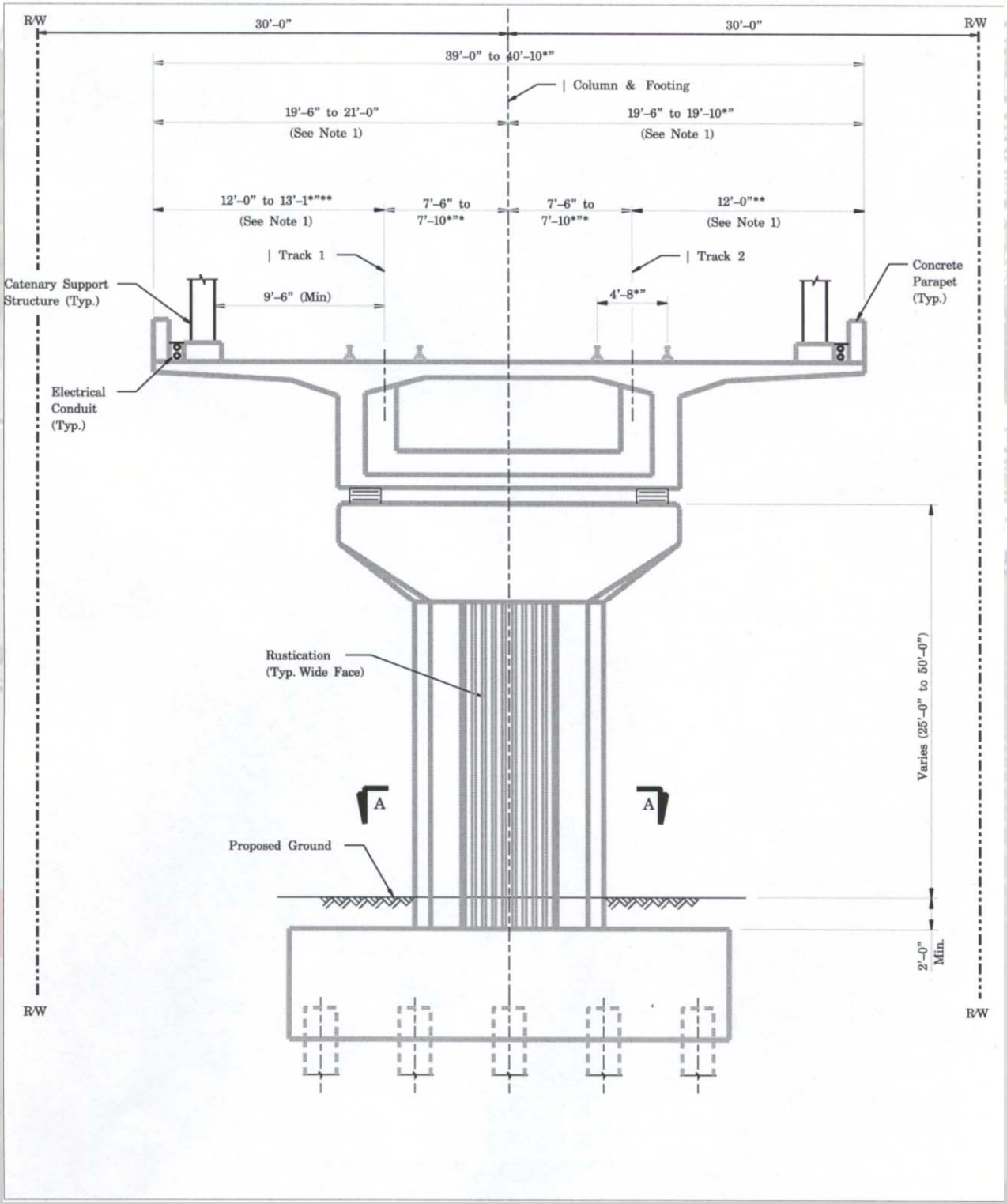
Source: Reinforced Earth Company

Rail Section

High Level Structure

For Double Track

High Level
$76.0 M/mi



Source: *Tampa to Miami Feasibility Study*, Florida High Speed Rail Authority, March, 2003

NCHRP Class 6 Barrier

$7.1 M/mi

Source: *From Roadside Design Guide 2002,* Copyright 2002, by the American Association of State Highway and Transportation Officials, Washington,DC. Used by permission. Documents may be purchased from the AASHTO bookstore at 1-800-231-3475 or online at http://transportation.org.

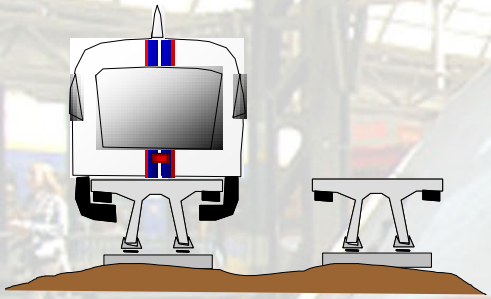
Crossing Drivers (< 110 mph) ($M/each)

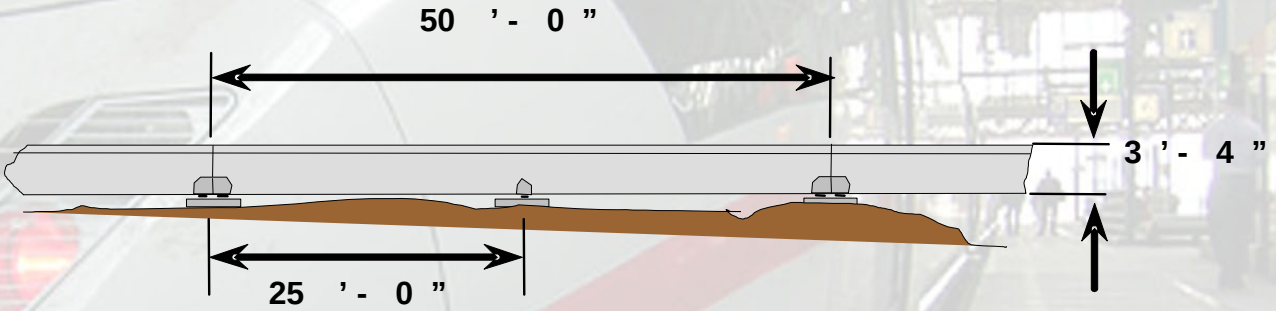
- Four Quadrant Gates $0.341
- Precast Panels & Road Impr $0.177

  Cost per crossing $0.518

- Grade separation for speeds greater then 110mph is required.
- Cost of grade separations, in most cases, is greater then $10M.

Maglev At Grade Guideway

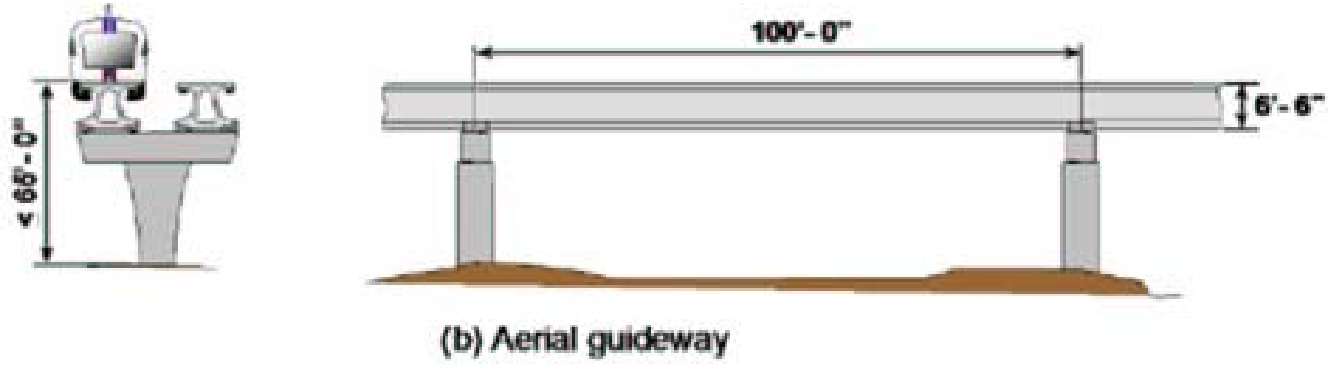




$18.0 M/mi

Source: SANDAG Maglev Study Phase 1, Final Report

Maglev Aerial Guideway

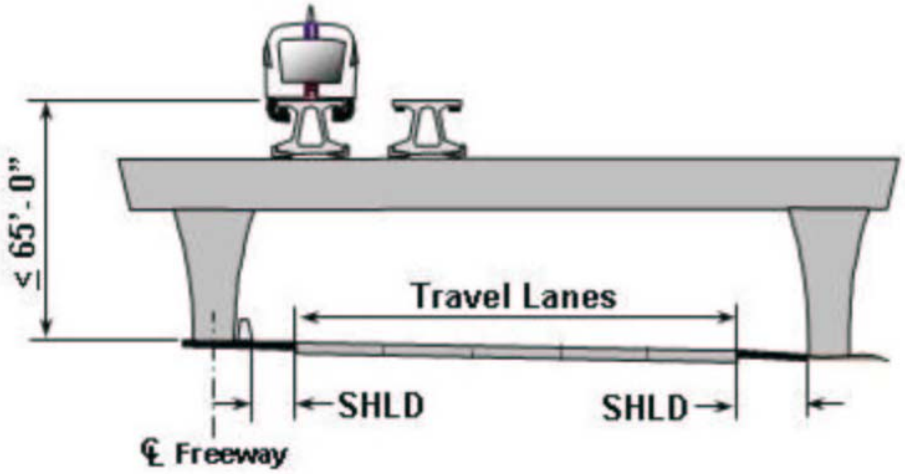


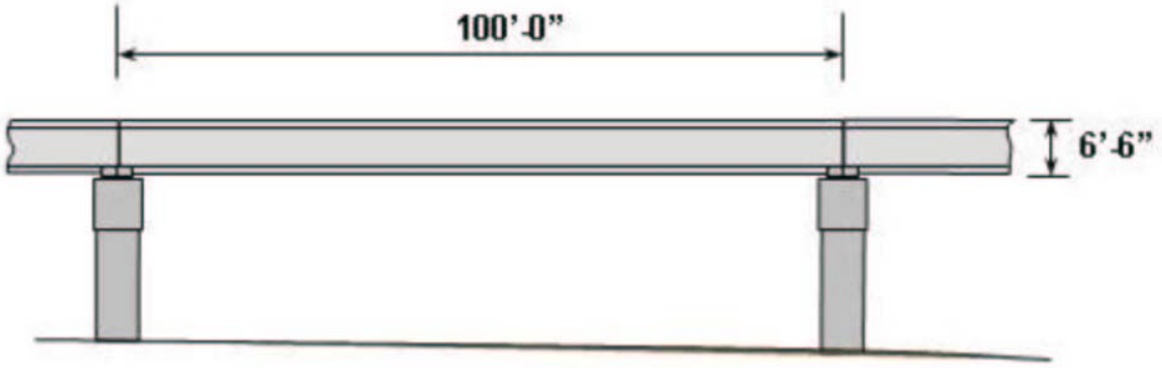
(b) Aerial guideway

$34.8 M/mi

Source: SANDAG Maglev Study Phase 1

MAGLEV Straddle Bent Over Highway



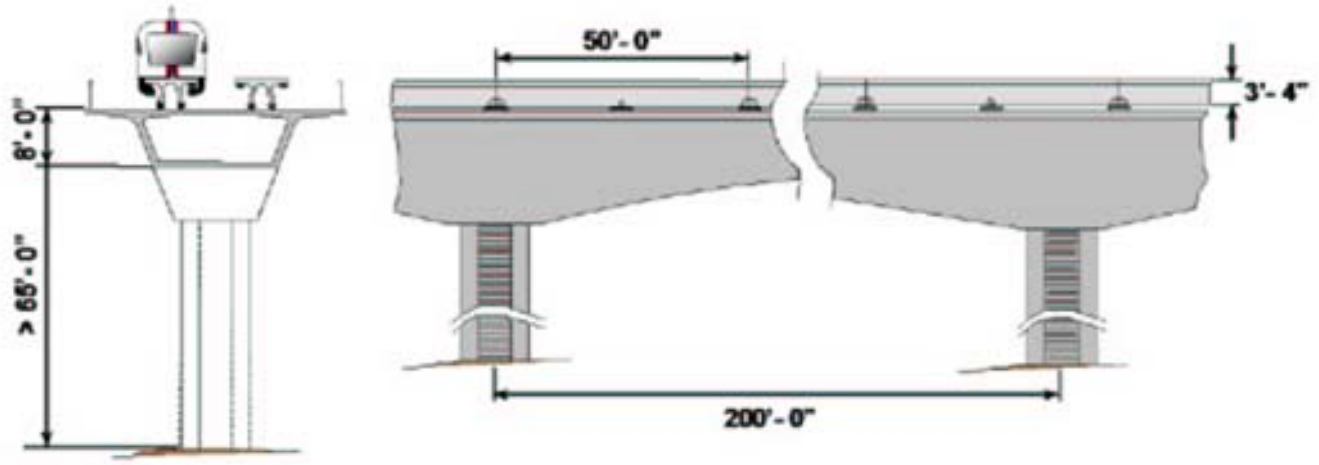


$46.5 M/mi

Aerial guideway type B

Source: SANDAG Maglev Phase 1 Final Report

Maglev Bridge Structure



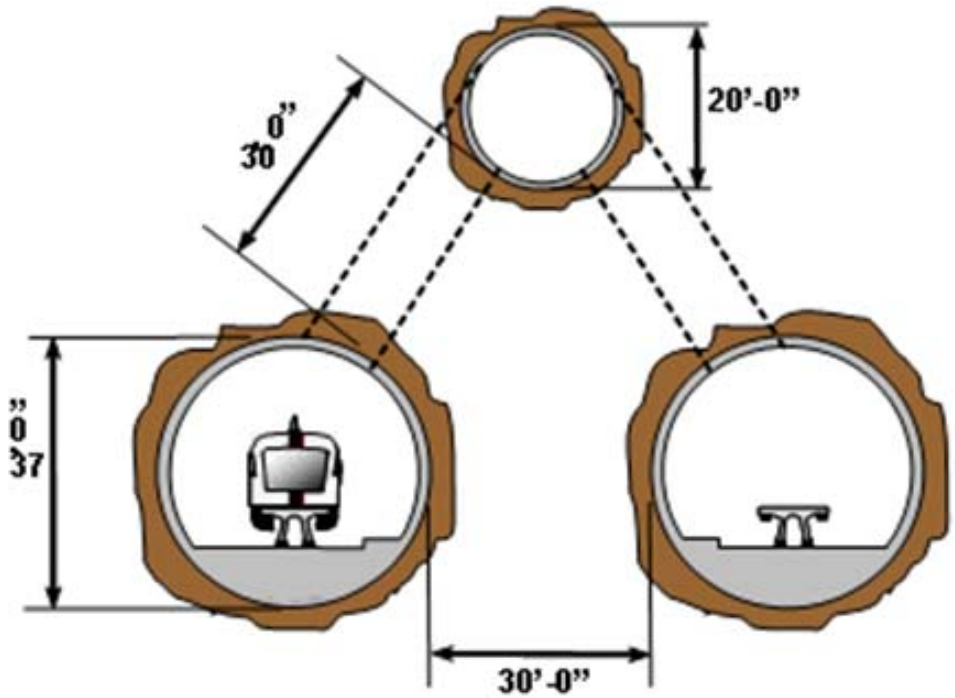
(c) Bridge structure

$136.2 M/mi

Source: SANDAG Maglev Study Phase 1

Maglev Tunnel

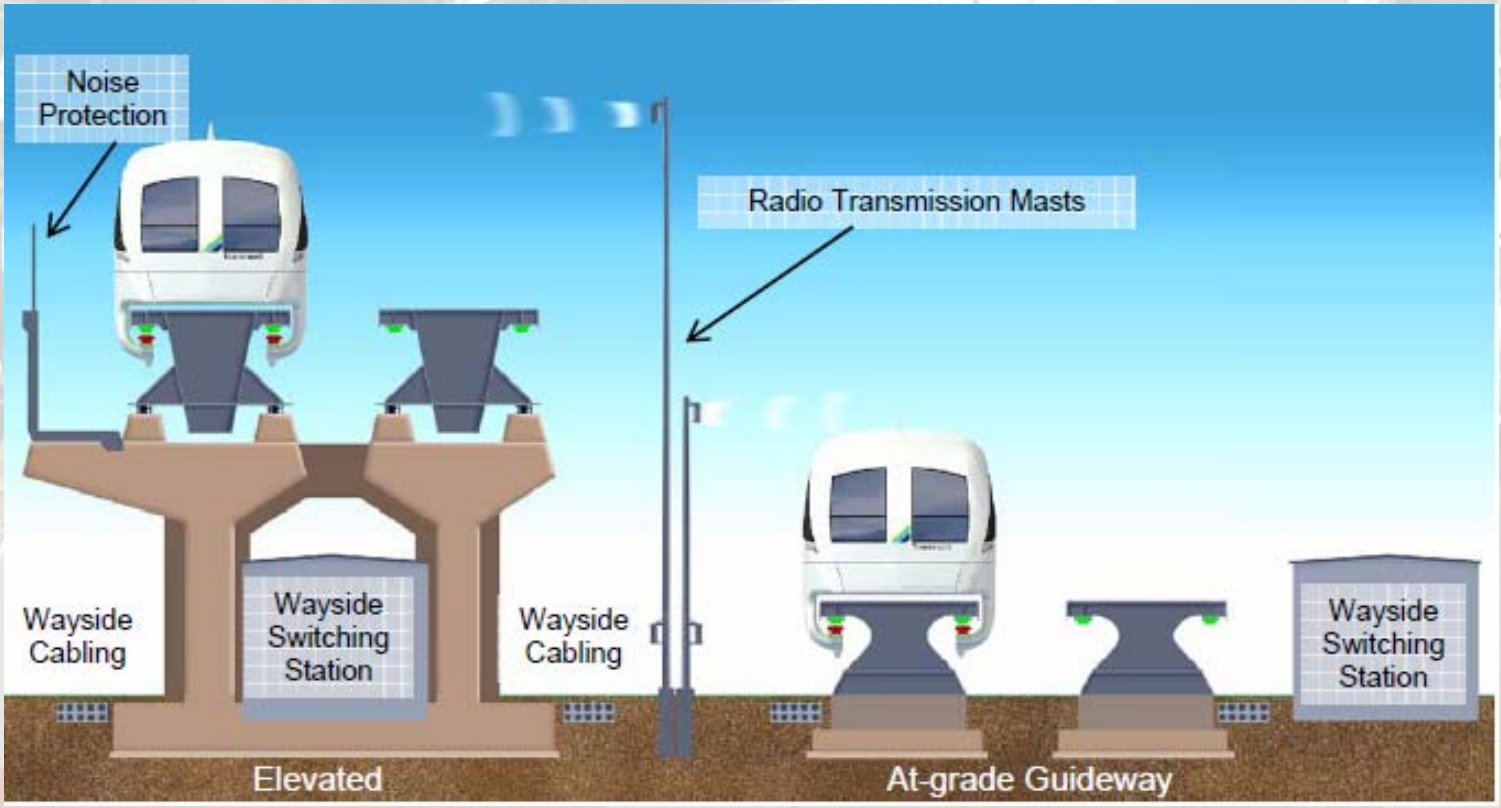
Shallow/ Short
$117.4 M/mi



Deep/ Long
$ 236.5 M/mi

Source: SANDAG Maglev Study Phase 1

Maglev Propulsion, Communication and Controls



VHS Maglev $19.7 M/mi
Urban Maglev $7.7 M/mi

Source: California Maglev website at www.calmaglev.org./
SANDAG Maglev Study Final

Land Acquisition Assumption
(100’ Right-Of-Way)

- **Rural -$129,000 per mile**
  - ➢Cost per acre –$10K
- **Urban - $387,000 per mile**
  - ➢Cost per acre –$30K
- **❖Potential Issues**
  - ✓Railroad Rights of Way
  - ✓Property takes
- **Information from CDOT confirms costs used for land acquisition estimates**

Contingency and Other Costs – 58%

Design and Construction Contingency	30%
Design Engineering	10%
Insurance and Bonding	2%
Program Management	4%
Construction Management & Inspection	6%
Engineering Services During Construction	2%
Integrated Testing and Commissioning	2%
Erosion Control and Water Quality Mgt	2%

Thank You.